NASA Innovative Advanced Concepts

Transformers For Extreme Environments

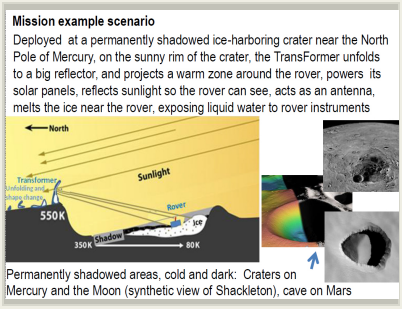
Completed Technology Project (2013 - 2014)

Project Introduction

Imagine a revolutionary way to remotely control the environment surrounding one or more roving vehicles exploring remote and unexplored areas of the Solar System, such as the dark interiors of craters or the depths of caves on Mars, the Moon, or Mercury. We call our solution "TransFormers" - multifunctional platforms that can change their shape and function and can enable new classes of in-situ planetary missions at massively reduced cost. Unfolding to large areas, they can reflect solar energy, warming and illuminating targets, powering solar panels, tracking movement and acting as a telecommunications relay. Placed on the sunny rim of a permanently-shadowed crater, or at the entrance to a cave, Transformers can be used in conjunction with rover exploration, projecting a favorable micro-environment into cold and dark areas. These challenging sites are particularly exciting and scientifically interesting. For example, water found in the permanently shadowed areas of craters on the Moon or Mercury can reveal clues about planetary formation and history, and could be used as a resource for astronauts. Cave exploration on Mars offers the possibility of finding extraterrestrial life; furthermore, caves are time capsules preserving geochemical traces and may safely shelter future human explorers.

Anticipated Benefits

The primary benefit of a TransFormer is to make possible affordable missions that require survival for long periods of time without direct or with limited solar input. This way, environments without sunlight (such as craters and caves) can use TFs located in Sun-illuminated areas outside to project energy inside the permanently shaded areas, power solar panels, heat, illuminate, and relay communications.



Concept Diagram

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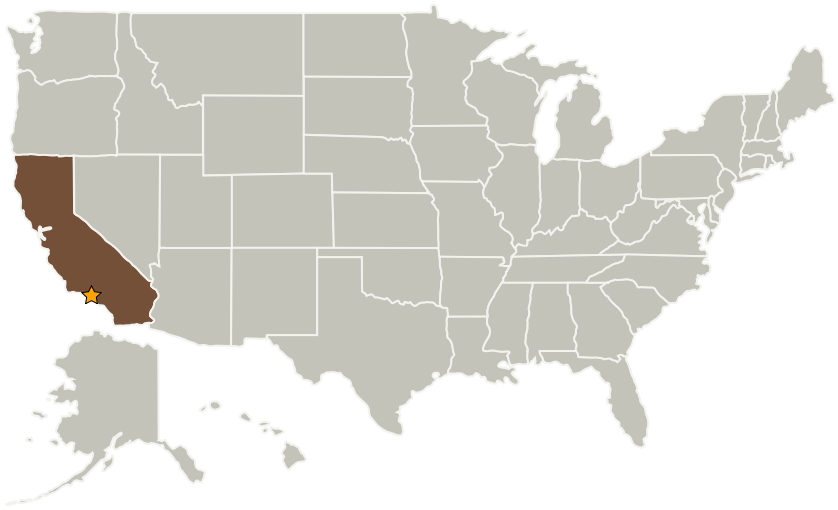


Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

October 2013: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

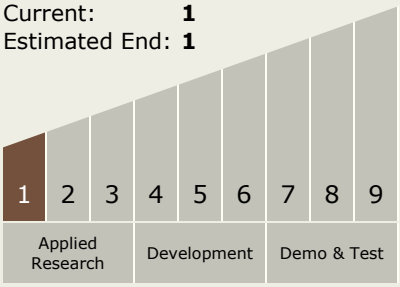
Eric A Eberly

Principal Investigators:

Adrian Stoica
Masakazu Hirokawa

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **1**



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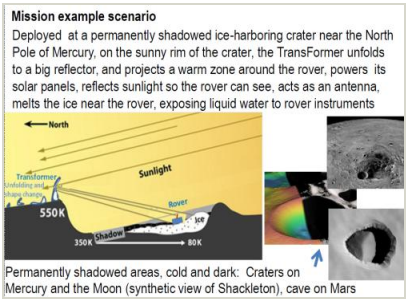
September 2014: Closed out

Closeout Summary: We have documented the findings of the Phase I study en titled TransFormers for Extreme Environments. We met the goals set forth in the proposal, and determined new opportunities, challenges, and risks for advancing the concept, which we propose to explore further in a Phase II study. We provid ed a general description of the TF concept and how it can assist in creating a fav orable micro-environment within a hard-to-survive-in extreme environment, foc using on providing power and heat to rovers operating in cold, dark places on th e Moon, Mars, and Mercury. We determined requirements for TFs from a high-le vel analysis of four mission scenarios, and a more refined analysis of the most p romising one, the Lunar South Pole scenario - most promising from the point of view of applicability and timeliness. The benefits of a TF to these missions was a ssessed. We provided a brief evaluation of the state of the art in industry for the functional areas that make subsystems of a TF, from electronics to sensing and actuation, and explored novel modalities in unfolding a large surface. We identifi ed the directions that are most relevant for advancing the concept.

Images



Transformers For Extreme Environments
Concept Diagram
(https://techport.nasa.gov/image/102060)

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.1 Below-Surface Mobility

Target Destinations

The Moon, Mars, Others Inside the Solar System